

# MONTHLY WEATHER REVIEW

Editor, JAMES E. CASKEY, JR.

Volume 82  
Number 10

OCTOBER 1954

Closed December 15, 1954  
Issued January 15, 1955

## SYNOPTIC BACKGROUND FOR RECORD APRIL MINIMUM TEMPERATURE AT FIRST CONNECTICUT LAKE, N. H., APRIL 4-5, 1954

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[Manuscript received June 30, 1954; revised August 23, 1954]

### INTRODUCTION

At 0700 EST on the morning of April 5, 1954, Hollis H. Young, cooperative observer for the U. S. Weather Bureau at First Connecticut Lake, N. H., recorded a minimum temperature for the past 24 hours of  $-17^{\circ}$  F. This extremely low value exceeded by  $5^{\circ}$  the previous April minimum of record for New England.

Because of the unusual nature of this temperature, an investigation was made into the attendant circumstances by the New England Climatological Section Center of the Weather Bureau. The First Connecticut Lake "Record of Climatological Observations" for April showed a maximum of  $+15^{\circ}$  for the 24 hours ending at 0700 EST on the 5th and a temperature of  $+9^{\circ}$  at the time of observation on the 5th. On the reasonable assumption that the  $+15^{\circ}$  occurred during the late afternoon of the 4th, it seemed almost impossible for the temperature to drop by  $32^{\circ}$  and then rise by  $26^{\circ}$ , all within some 15 hours. Further investigation, however, revealed that the  $-17^{\circ}$  was by no means as improbable as it first seemed. This paper presents the results of the investigation.

### LOCATION AND EXPOSURE

Mr. Young has served as cooperative observer for the Weather Bureau since October 1, 1919. He has therefore 35 years of experience, and his climatological reports over this long period have been considered outstanding in accuracy. Moreover, he verified by subsequent letter

that the value of  $-17^{\circ}$ , as entered on his monthly "Record of Climatological Observations," was correct. Hence there can be no doubt as to the genuineness of the reading.

The climatological station where this record was obtained is located in extreme northern New Hampshire, at a point 14.5 miles south of the tip of the State. Its coordinates are  $45^{\circ}06'$  N. latitude,  $71^{\circ}17'$  W. longitude; elevation of the instrument shelter is 1,660 ft. The northernmost portion of New Hampshire is shaped like a rough square, about 20 miles to each side. It is mountainous, well-watered, and forested country. The topography east of the Connecticut River to the Maine line is basically a confused set of small valleys running into the Connecticut Valley. This eastern part has the highest elevation of the region, with summits up to 3,600 ft. West of the river, there are two long and narrow valleys with three intervening ridges, all oriented northeast-southwest. Ridge elevations are generally in the 2,000 to 2,500-ft. range, valley bottoms 500 to 1,000 ft. lower, though the highest ridge point is over 3,100 ft.

The large-scale topographic features surrounding the First Connecticut Lake station have been outlined because the very low temperature under consideration suggests that cold-air drainage may have been an important contributory factor. With this possibility in mind, figure 1 has been reproduced to show the land surface details within a 3-mile radius of the station, and figure 2 gives a close-up of the terrain immediately surrounding it. The thermometer shelter is set on open, grassy, slightly sloping land, about 75 ft. away from the nearest building and 200 ft. away from the nearest line of trees.

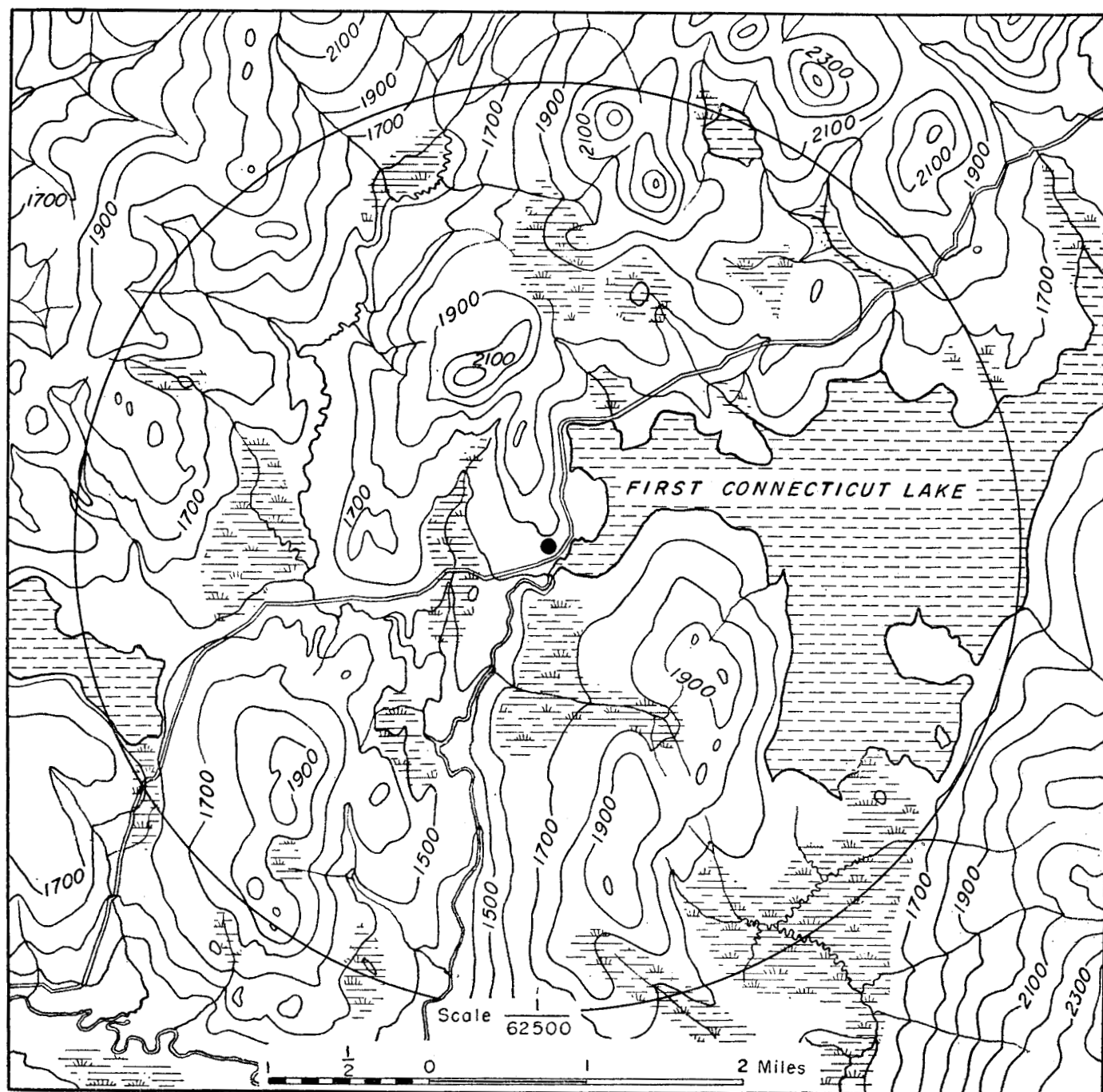


FIGURE 1.—Map showing topography within a 3-mile radius of cooperative observation station at First Connecticut Lake, N. H.

This is obviously an excellent exposure for a thermometer shelter, one which cannot be said to be influenced by any artificial heat- or cold-sources. Figures 1 and 2 indicate, however, that it is susceptible to cold-air drainage. The evidence of topography and exposure would seemingly demonstrate that the First Connecticut Lake station has an excellent location and is subject to local cold-air drainage under appropriate atmospheric conditions. Further, its elevation, latitude, and nearness (relative to most of New England) to the source region of Canadian air masses furnish additional support to the likelihood of its recording extremely low temperatures

even in April. Finally, the fact that First Connecticut Lake has established several monthly minimum temperature records for New Hampshire shows that it is undeniably a "cold spot."

#### SYNOPTIC SITUATION

Figures 3-8 present the series of 12-hourly surface weather maps and upper-air charts during the period from 0130 EST of April 4 to 1330 EST of April 5. Figure 3 shows that the northeastern United States was dominated on the night of April 3 and the morning of the 4th by an extensive anticyclone and an associated outpouring of

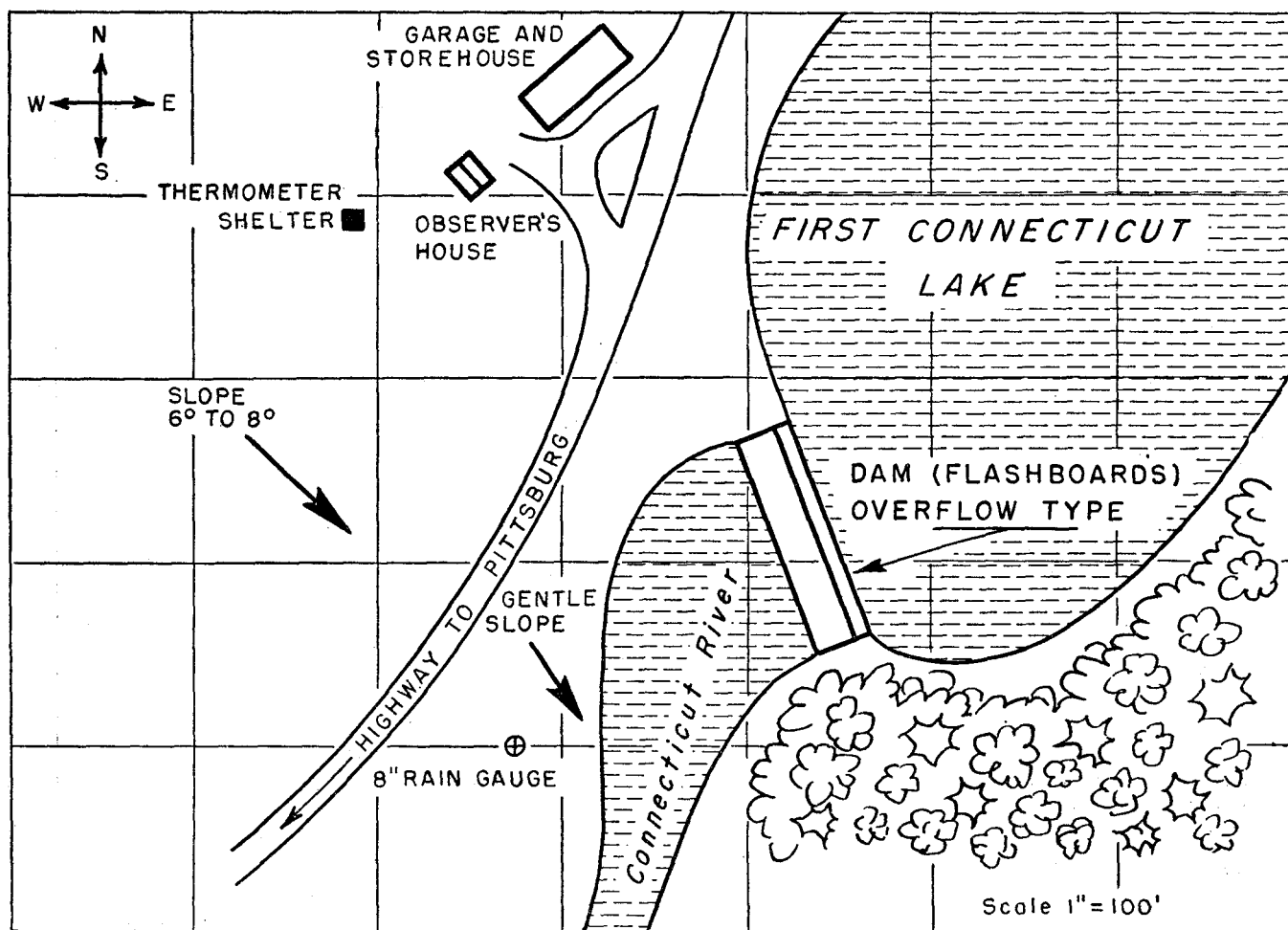


FIGURE 2.—Sketch map of details of immediate surroundings of station at First Connecticut Lake.

cP air from the Hudson Bay region of Canada. Winds were light to moderate and generally westerly over New England; skies were clear except in northern Vermont; temperatures were approximately  $15^{\circ}$ – $20^{\circ}$  below normal over the entire section. By 1330 EST of the 4th (fig. 4), the surface High had drifted eastward and the ridge-line, oriented in a northwest-southeast arc, extended across eastern New York State from the head of the St. Lawrence River to Long Island. New England continued to be on the cold side of the anticyclone, and afternoon readings on the 4th were decidedly subnormal. The 700-mb. constant-pressure chart for 1000 EST of the 4th (fig. 5) shows the strong upper-level northwest flow that was maintaining very low temperatures over New England.

Figure 6 represents the surface weather conditions at 0130 EST of the 5th. It is immediately apparent that the High, now centered off the Middle Atlantic Coast, has moved rapidly eastward during the previous 12 hours and that the ridge-line, though less distinct than on the earlier map, is probably located so that only Maine of the New England States still lies on the cold side. This latter point is significant, since it means that the minimum value of  $-17^{\circ}$  read at First Connecticut Lake at 0700

EST of the 5th must have occurred close to 0130 EST of the same date.

Figure 6 assumes importance, then, in that it indicates the synoptic situation that existed within a few hours of the estimated time of occurrence of the record minimum. The map shows either calm conditions or light to gentle variable winds over New England, clear skies except for Connecticut and (probably) the western Massachusetts-southern Vermont region, and continued subnormal temperatures. A glance at the map with a view toward explaining the  $-17^{\circ}$  at First Connecticut Lake reveals that the surface weather situation favored strong nocturnal radiation. Moreover, it favored local cold-air drainage, a possible contributory factor considered in the previous section of this paper.

Figures 7 and 8 are the surface map and 700-mb. chart for 1330 EST and 1000 EST, respectively, of the 5th. A comparison of these with figures 4–6 reveals a striking change in the circulation pattern over New England. At the surface, the incipient southwesterly flow and consequent warming trend suggested by figure 6 are realized in figure 7. Aloft, the cold northwesterlies that dominated the region have been replaced by vigorous westerlies and

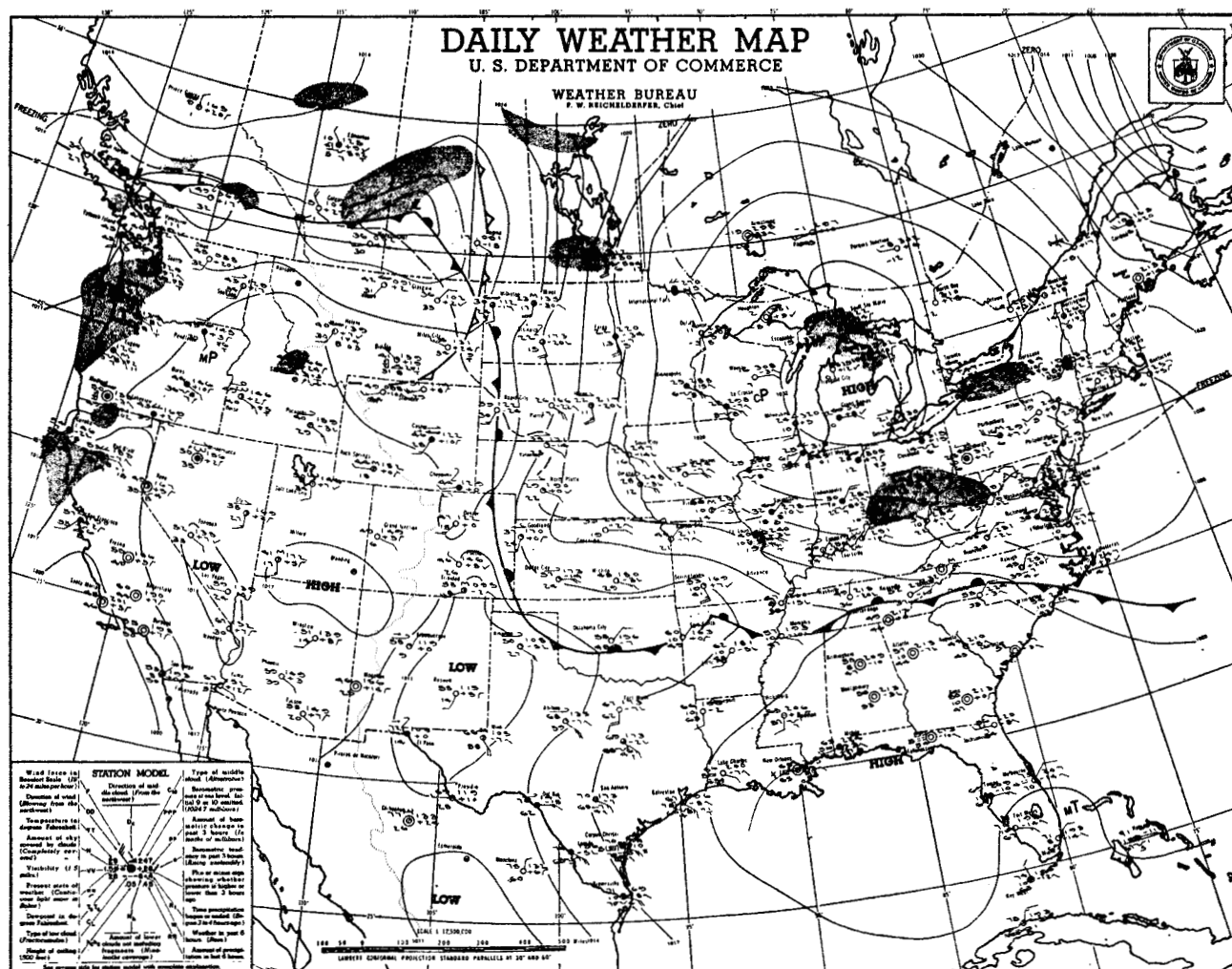


FIGURE 3.—Surface weather map, 0130 EST, April 4, 1954. Note position of extensive High in relation to northeastern States.

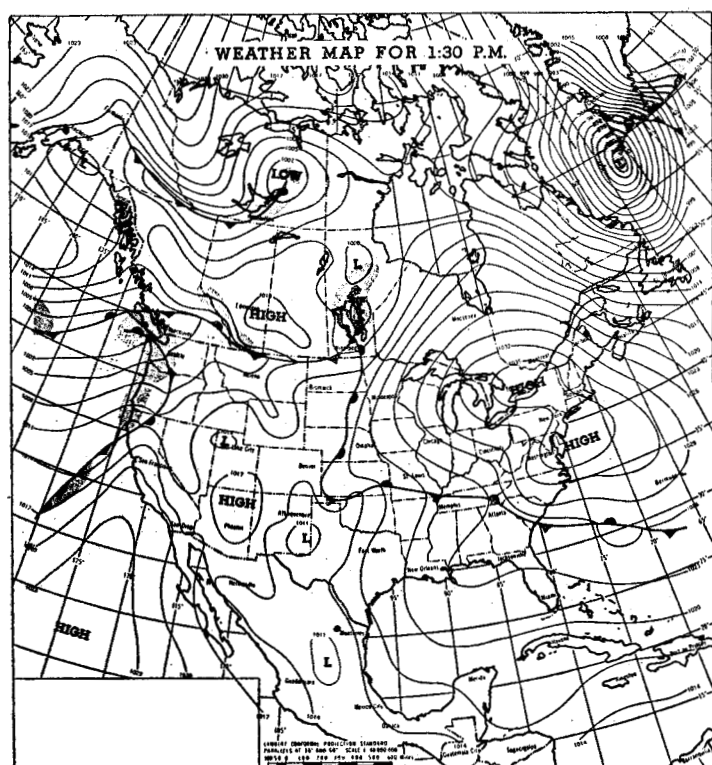


FIGURE 4.—Surface weather map, 1330 EST, April 4, 1954.

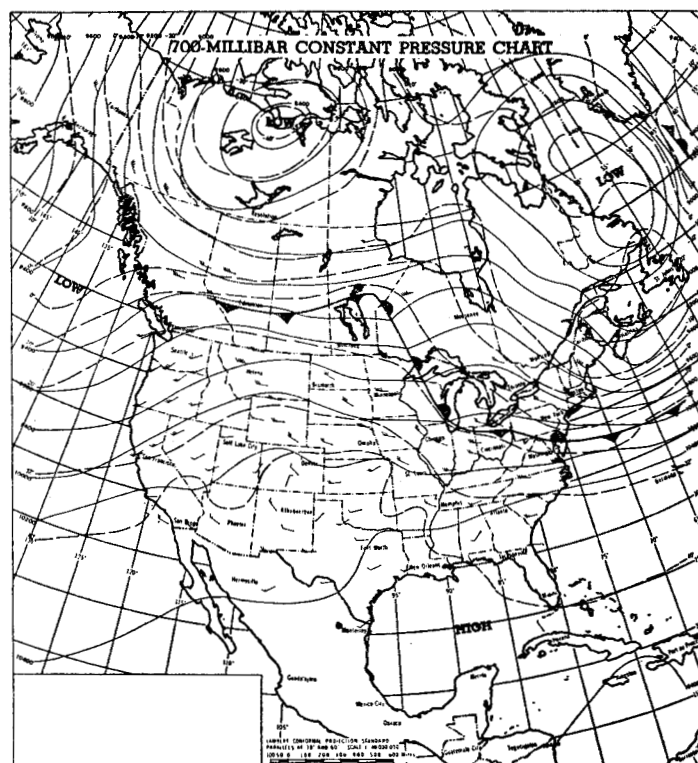


FIGURE 5.—700-mb. chart, 1000 EST, April 4, 1954.

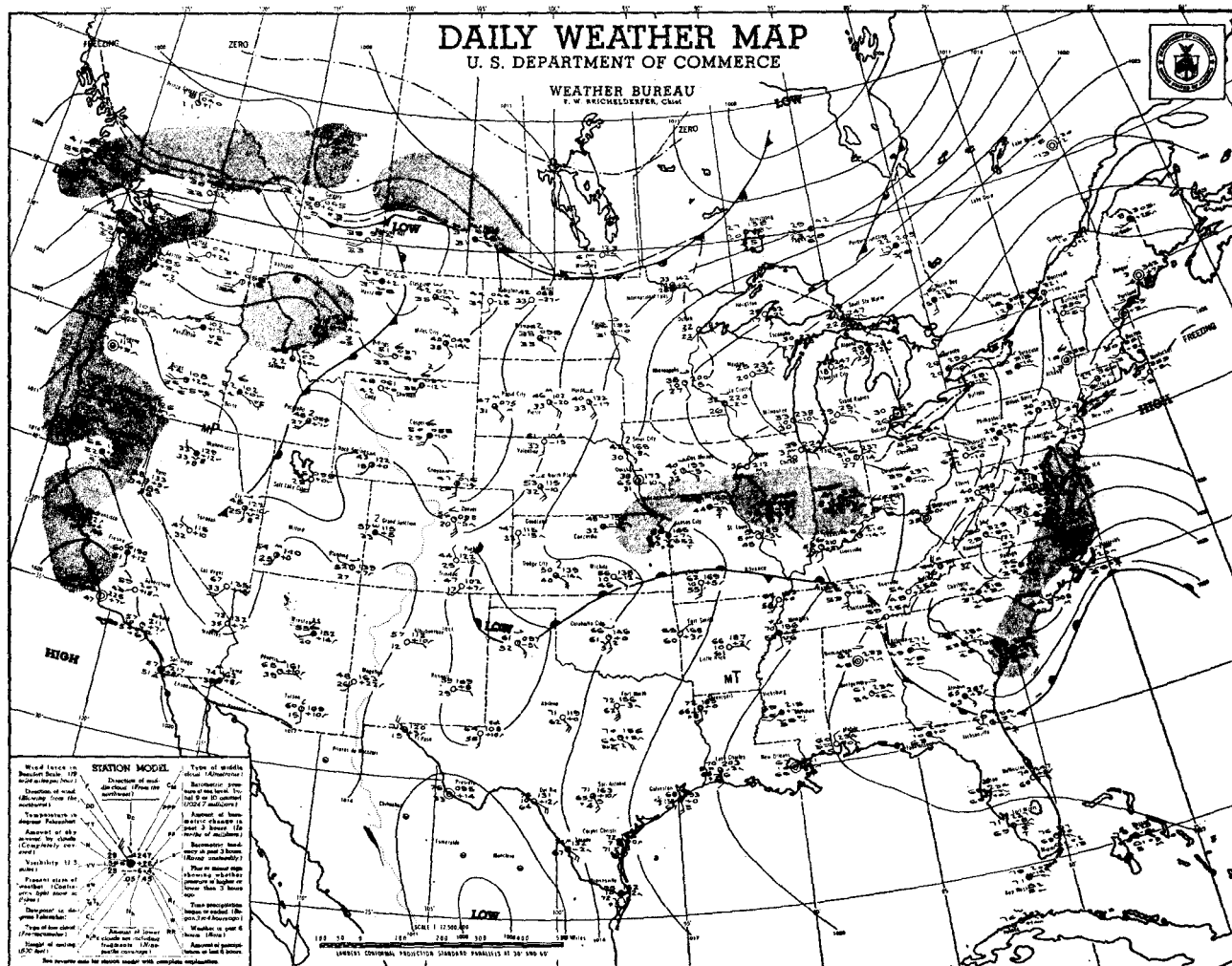


FIGURE 6.—Surface weather map, 0130 EST, April 5, 1954, near the time of occurrence of the record minimum at First Connecticut Lake station.

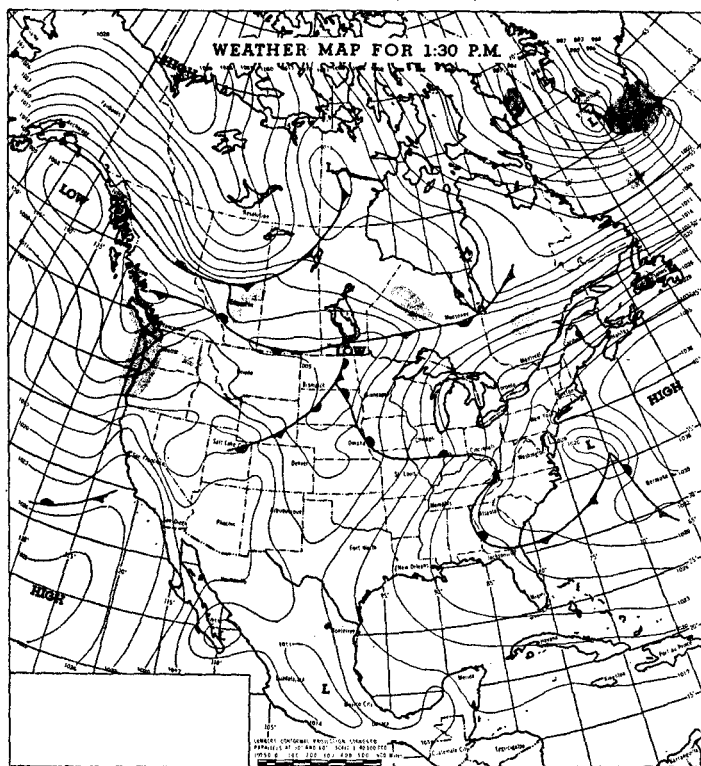


FIGURE 7.—Surface weather map, 1330 EST, April 5, 1954. Note the change in position of High from figure 3 and consequent change in wind direction and temperatures over northeastern States.

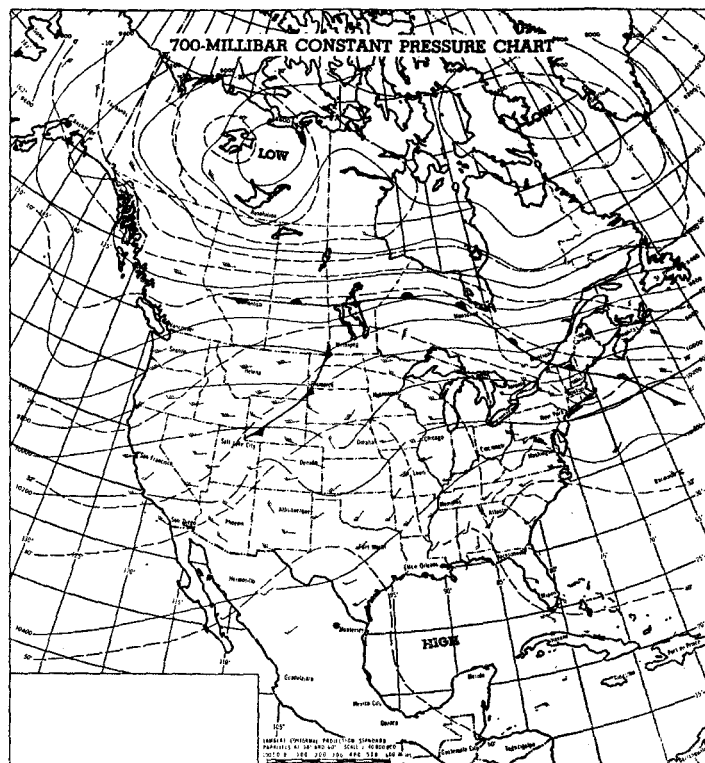


FIGURE 8.—700-mb. chart, 1000 EST, April 5, 1954. Compare with figure 5.

the warm air at the 700-mb. level has pushed northward practically into Maine. Temperatures at the 700-mb. level over New England are roughly  $20^{\circ}$  warmer in figure 8 than in figure 5. A considerable increase in cloudiness over that shown by figure 6, also may be inferred from figures 7 and 8.

Inspection of the facsimile pibal charts for the 3,000-ft. level (not reproduced here) disclosed that, at 1000 EST of the 4th, winds were light northwesterly over New England and the High, mentioned in connection with figures 4 and 6, was centered over western New York State. At 1600 EST of the same day, the High center was located near New York City, and the ridge-line extended down across eastern New York State, between Burlington, Vt. (which had a northwest wind), and Syracuse, N. Y. (west-southwesterly wind); the Albany, N. Y., wind report was missing. At 2200 EST of the 5th, the High was centered off the Virginia coast, with the ridge-line stretching northward into northern New Hampshire. The Burlington, Vt., report was missing, but both Albany and Syracuse had west-southwesterly winds, 15–20 knots. At 0400 EST of the 5th, winds at Albany were southwest at 10 knots and at Burlington, southwest at 20 knots. The wind was also southwest at Boston and Nantucket, Mass., and Hartford, Conn. Six hours later, southwesterly flow prevailed over all New England.

About 0400 EST of the 5th, therefore, the low-level wind field over northern New Hampshire shifted from light northwesterly to increasing southwesterly. This fact was substantiated, along with an associated rise in temperature and development of cloudiness, from observations at Mount Washington, N. H., and Burlington, Vt., the only first-order stations within 100 miles of First Connecticut Lake.

From this analysis of the pertinent synoptic features between the morning of April 4 and the afternoon of April 5, a working hypothesis may be developed to account for the First Connecticut Lake minimum: (1) The  $-17^{\circ}$  occurred between 0130 EST and 0400 EST of the 5th. (2) It was produced by the presence of unseasonably cold Canadian air under circumstances which favored a rapid temperature drop, of the order of  $30^{\circ}$  between sunset of the 4th and (approximately) midnight. (3) These circumstances were, primarily, clear skies and calm or very light general winds, and secondarily, local cold-air drainage. (4) By about 0400 EST of the 5th, these conditions were abruptly reversed. Warmer air and cloudiness moved in swiftly from the southwest, causing a temperature rise of the order of  $25^{\circ}$ , between midnight and 0700 EST of the 5th.

### REGIONAL WEATHER

It has been shown (see figs. 3–5) that northern New England was engulfed on April 4–5 by an extremely cold continental polar air mass. In figures 9–11 are plotted the temperatures that occurred on these dates at a number of stations in the northern two-thirds of Vermont and New Hampshire and the western half of Maine. Through the

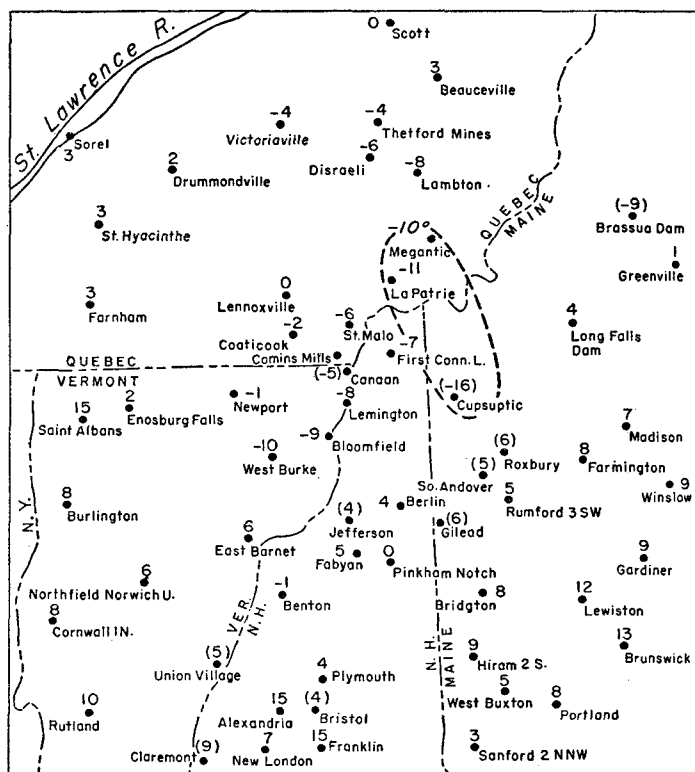


FIGURE 9.—Minimum temperatures ( $^{\circ}$  F.) on the night of April 3–4, 1954, in upper Vermont and New Hampshire, western Maine, and neighboring Quebec. Values in parentheses were read from unofficial equipment but are considered reasonably reliable. Dashed line is  $-10^{\circ}$  isotherm.

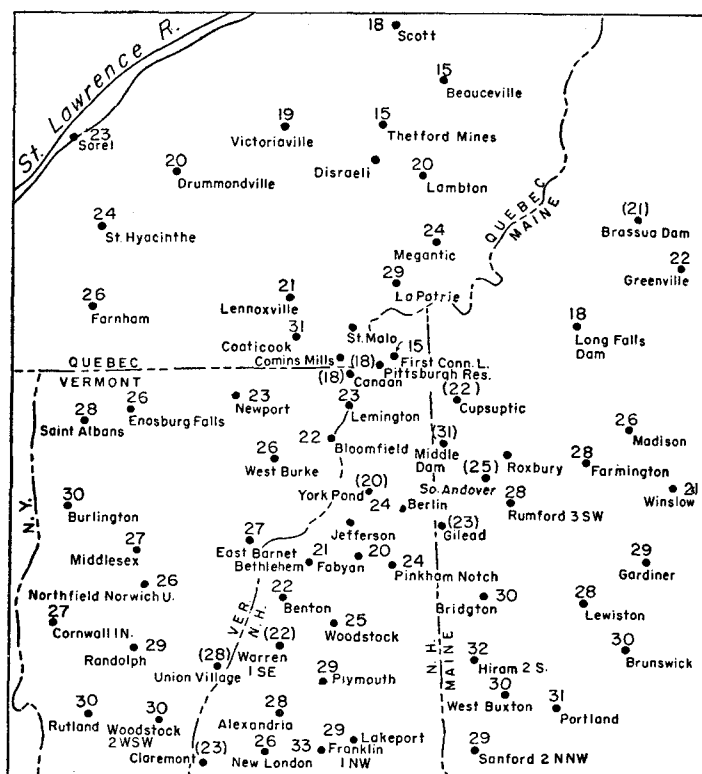


FIGURE 10.—Maximum temperatures ( $^{\circ}$  F.) on April 4, 1954, for same stations as in figure 9. Parentheses indicate unofficial readings.



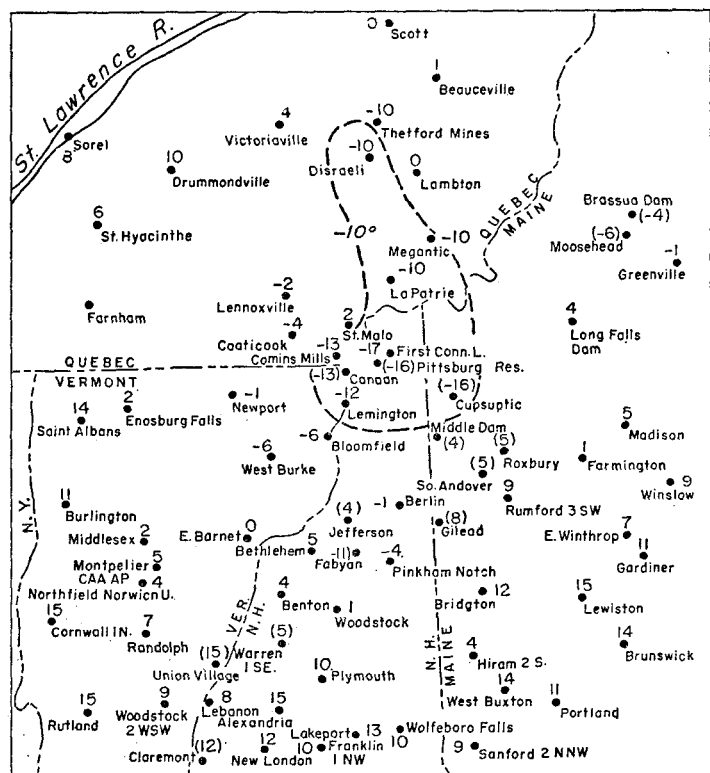


FIGURE 11.—Minimum temperatures ( $^{\circ}$  F.) on the night of April 4-5, 1954, when the record  $-17^{\circ}$  occurred at First Connecticut Lake. Stations are those used in figures 9 and 10 and parentheses indicate unofficial readings. Dashed line is  $-10^{\circ}$  isotherm.

courtesy of Dr. Andrew Thomson, Controller of the Canadian Meteorological Division, Air Services, Department of Transport, readings taken at stations in the adjoining portion of the Province of Quebec are also included. Values enclosed in parentheses are from unofficial thermometric equipment. The equipment is standard in most cases, however, and the values are considered sufficiently reliable for use in this analysis.

Figure 9 gives the minimum readings on the night of April 3-4, when the outpouring of cold Canadian air, shown in figure 3, was the dominant regional weather control. Subzero temperatures covered a wide area in the upper Connecticut Valley, along the northern Maine boundary, and the bordering region of Quebec. The rest of the area in figure 9 had temperatures generally in the  $0^{\circ}$  to  $+10^{\circ}$  range. The normal minimum values for this time of year range from approximately  $30^{\circ}$  in the south to  $15^{\circ}$  in the north, so that the temperatures shown in figure 9 average some  $15^{\circ}$ - $20^{\circ}$  below normal.

In figure 10 are shown the maximum temperatures for April 4. They range from the low 30's in the southern portions of Vermont, New Hampshire, and Maine, to the high and middle teens in the mountains of northern New Hampshire, in northern Maine, and the adjacent part of Canada. Temperatures in the 20's predominate over most of the area shown in figure 10. These readings are generally 20°-25° below normal.

Thus, antecedent to the record First Connecticut Lake minimum on the night of the 4-5th, extremely low temperatures were established over the region under examination. A contributing factor to these low temperatures, aside from the character of the unseasonably cold air mass involved, was the existence of a deep snow cover. During the first five days of April, snow overlaid all three of the northern New England States. On the morning of the 5th, depths ranged from traces along the Maine coast, and in southern Vermont and New Hampshire, to 6 inches over northern Vermont, 6-20 inches over central New Hampshire and the central interior of Maine, and 20-30 inches over extreme northern New Hampshire and the northern interior of Maine. Snow cover data have not been obtained for the neighboring district of Canada, but they may reasonably be assumed to be in the 6-20 inch range.

The stage was set, therefore, for the record First Connecticut Lake minimum as shown in figure 11. The most striking feature of this chart is perhaps the concentration of very low minima ( $-10^{\circ}$  and below) in a roughly elliptical area lying about the First Connecticut Lake station. The values enclosed by the  $-10^{\circ}$  isotherm substantiate the record reading. The  $-16^{\circ}$  shown for Pittsburg Reservoir, immediately southwest of First Connecticut Lake, was taken with a Six's thermometer exposed in a small instrument shelter at the cooperative recording rain gage station there. This station is only 5.5 miles southwest of the First Connecticut Lake station, and the close agreement between the two minima offers mutual confirmation of their accuracy. The  $-16^{\circ}$  shown for Cupsuptic, Maine, 25 miles east-southeast of First Connecticut Lake, was observed at an unofficial station using standard thermometers and Weather Bureau-type shelter. Exposure of instruments and quality of temperature readings there are good. The  $-13^{\circ}$  at the Canaan, Vt., cooperative (precipitation only) station, was measured with a reliable U-tube thermometer installed in a well-exposed but small shelter. No information is available on the Canadian station at Comius Mills, where  $-13^{\circ}$  also occurred on the night of the 4-5th. The  $-12^{\circ}$  at the Lemington, Vt., full climatological station, taken with official equipment, equalled the previous April low reading for New England and constituted a new monthly minimum record for Vermont.

## CONCLUSION

It would seem well established, therefore, that a very cold core of air was settled on the night of April 4-5, 1954, over an area roughly 35 miles in diameter and centered on First Connecticut Lake. This air mass was unseasonably chilly to begin with, and extreme minimum temperatures were favored by the presence of a deep snow cover and ideal nocturnal radiation conditions until approximately 0400 EST of the 5th. As previously suggested, local air drainage may also have contributed to the  $-17^{\circ}$  reading.

After 0400 EST the regional atmospheric circulation changed suddenly and radically, to advect milder air with increased sky cover, but not before a new April minimum temperature record for New England had been established. It may be of interest to note that, except for a reading of  $-24^{\circ}$  at North Lake, N. Y., on April 1, 1953, no temperature lower than the First Connecticut Lake value has ever been recorded during April in the entire northeastern United States.

#### ACKNOWLEDGMENTS

The authors wish to thank those whose information and

advice aided materially in the preparation of this paper. These include: Dr. Andrew Thomson, Controller, Meteorological Division of the Canadian Department of Transport; Weather Bureau officers at Caribou and Portland, Maine, Concord, N. H., Burlington, Vt., and Albany, N. Y.; Cooperative Observers in northern New England, especially Mr. H. H. Young at First Connecticut Lake, N. H., Mr. C. L. Covill, Engineer at Murphy Dam, Pittsburg, N. H., and Mr. E. F. Fenn of the Brown Co. at Berlin, N. H.; and Mr. Morton J. Rubin of the Southern Hemisphere Unit of the U. S. Weather Bureau at Boston, Mass.

#### CORRECTION

Monthly Weather Review, Chart VIII: Correct coordinates for the solar radiation equipment at Oak Ridge, Tenn., are  $35^{\circ}55'$  N.,  $84^{\circ}19'$  W. Data for Oak Ridge have been plotted about 140 miles too far northeast in previous issues.